



MATERIALS & INTRODUCTION TO MANUFACTURING

Materials & Manufacturing Report



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CALLUM PITT (P151991)

Executive Summary

This report will investigate how my chosen product is manufactured, analyse the materials used and look at the environmental impact this has. It will also look into the volumes that are produced of this product and the health and safety implications.

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Introduction

The product chosen for this report is the 'Polymer Moulded Bottle Assembly' as this is an everyday product that we use without really thinking about how it is made. The aim is to see how they are manufactured, what materials are used, the volumes manufactured and any environmental problem with their creating. Health and safety concerns will also be investigated.

Findings

As covered in (Groover, 2010), plastic bottles are manufactured by blow moulding, this is where a soft plastic tube known as a parison is inflated using air pressure inside a mould cavity. The plastic fills the mould in order to create the bottles shape. This way of manufacturing bottles can be used for very high volumes as is required for the modern world. Many products found in supermarkets use this type of bottle such as drinks, ketchup, cooking oil etc. Around 10% of world plastic is used on this process.

There are three main types of blow moulding;

- Extrusion Blow Moulding
- Injection Blow Moulding
- Stretch Blow Moulding

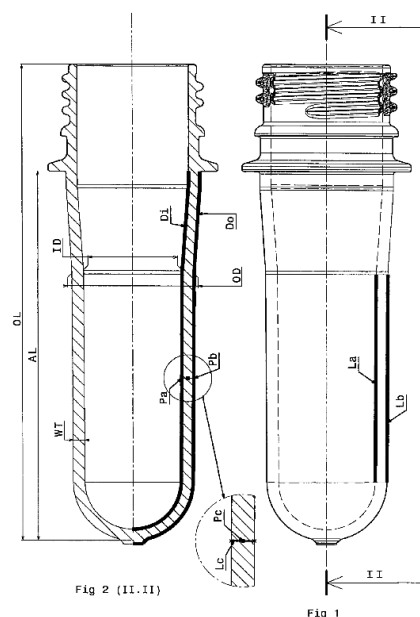
(The Plastic Bottles Company, 2017)

The Process

All types of blow moulding have three main stages;

1. Polymer pellets or granules stored in a hopper attached to the machine are heated and drawn into a worm screw.
2. The worm screw drives the molten polymer into the shot chamber and through various methods the parison or preform is made.
3. The parison is then inflated with compressed air inside a larger mould to form the shape of the bottle. The bottle is ejected and trimmed as necessary. The process repeats.

(DuPont, n.d.)



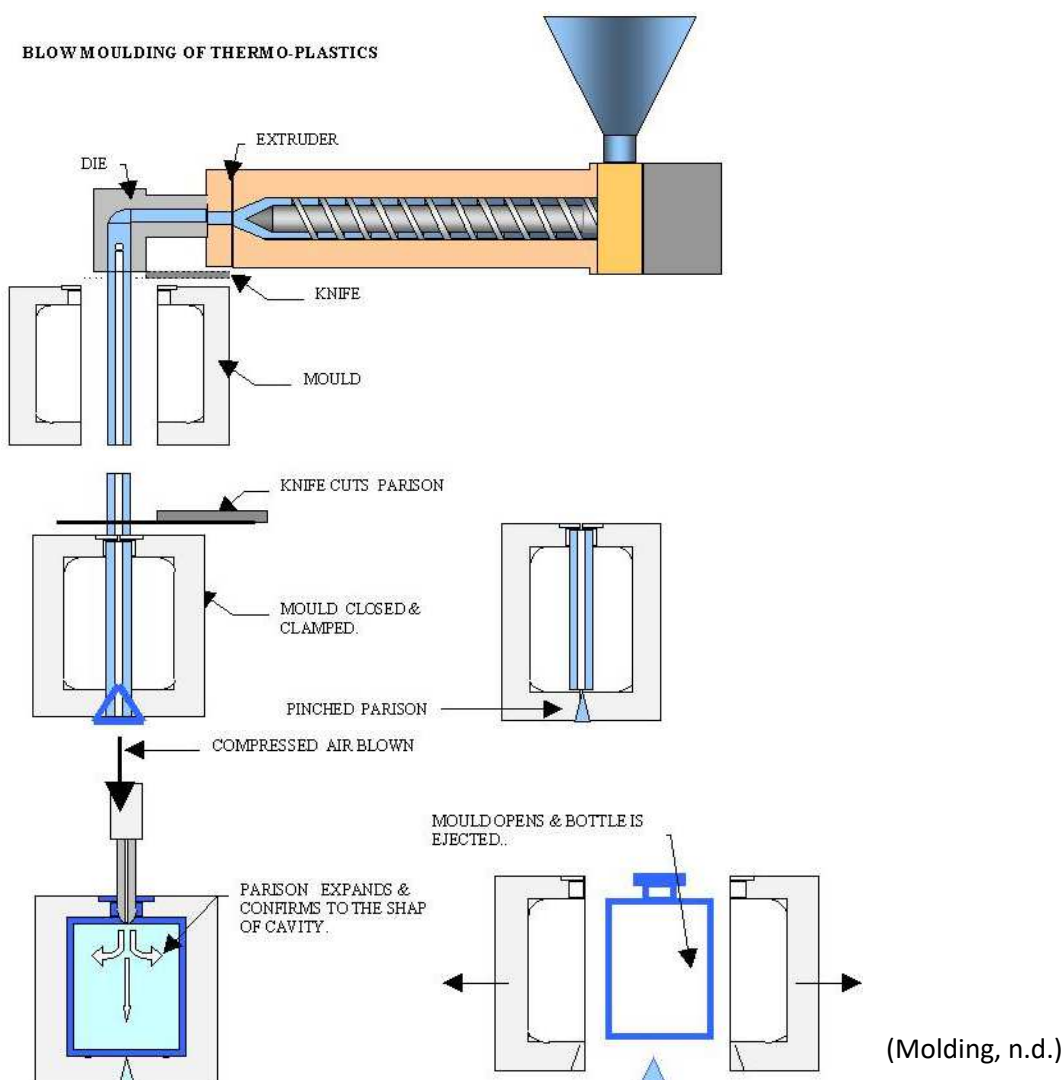
(Google, 2005)

Most blow moulding machines are set up with other operations further down the line such as bottle filling, capping and labelling. This keeps the whole process in one area from start to finish rather than transporting the empty bottles to another location. This would add transportation costs which would in turn reduce profits and/or increase the cost for the customer.

Extrusion blow moulding is the simplest form of blow moulding. A plastic tube of material is extruded into a mould cavity. When enough material is extruded the mould clamps the plastic at one end, creating a seal and air is injected at the other end. The bottle inflates until the plastic material reached the edges of the mould. The plastic then cools and the bottle becomes rigid. This is the cheapest of the three methods to set up but is the most wasteful and has least control over wall thickness.

In injection blow moulding the part known as a parison in extrusion blow moulding is called preform (Abramo, 1998). This method is capable of faster production and reduced waste as well as increased accuracy on wall thickness. However, the initial outlay for the moulds and equipment is more expensive especially for larger parisons.

Stretch blow moulding is a variation of injection blow moulding in that the air blowing rod pushes down into the parison stretching it out before injecting the air. This results in the final product being more rigid, and with a higher impact resistance. This also makes the bottle more transparent. The extra rigidity gained by this process makes an ideal bottle for carbonated beverages. (Groover, 2010)



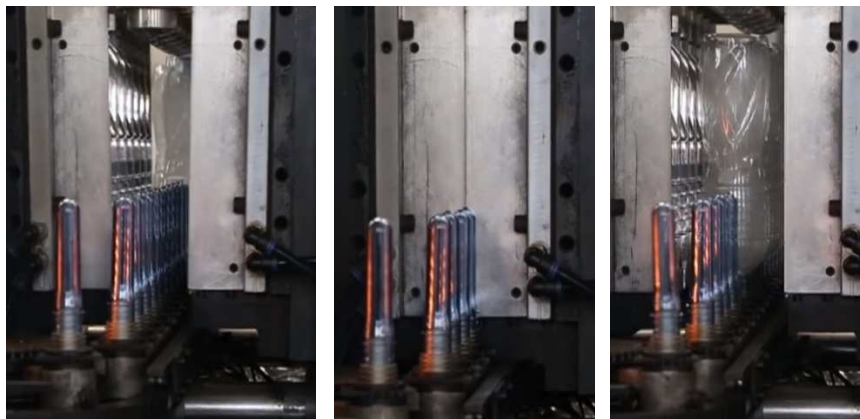
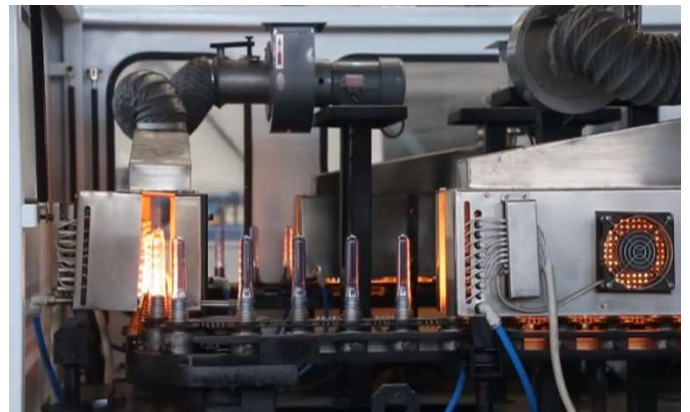
Modern Machines

As mentioned previously it is common for the entire process of making bottled beverages to be created at one facility, going from raw plastic to bottle as well as filling and labelling.



Parisons are injection moulded and loaded into slider read to go into the blow moulding machine.

The parisons go through two stages of heating. This particular machine moves four



The parison moves into the mould ready for inflation. The base of the bottle moves into place and the mould seals. Air inflates the bottles and the mould opens. The line moves on and the next four parisons move in. This process takes around four seconds.

The bottles are then inverted to be cooled before moving into the next station for filling.





The bottles are then filled with water in this case and immediately capped a split second later. The bottles then move on to labelling and are manually removed from the production line by an operator to be stacked for shipping.

All images from (ASG Machinery, 2016)

Origins

The origins of blow moulding can be traced back to early civilisations carrying out glass blowing, it is believed that Syrian glassblowers developed the method in the 1st century BC and it was then adopted by the Romans between the 1st and 3rd centuries AD. (Britannica, 1998)

However, it was not until the late 1800s that a patent was granted for a machine that would use a mould cavity and pressurised air to blow celluloid sheets into it. By the 1930s this method had developed to inflating tubes of melted material inside a closed mould similar to the methods of today. However, it wasn't until after World War II that low density polyethylene (LDPE) became available. This started the mass production of flexible bottles being used for household products. Similarly, in the 1950s, high density polyethylene (HDPE) moved the technology on further again. Milk bottles began to move to plastic during this time.

From an industrial standpoint it wasn't until the 1970s and the availability of PP and PVC grades that were suitable for blow moulding. (Abramo, 1998)

The Parison

The first step of blow moulding is to create the parison, this is the plastic part that will be inflated at a later stage. This is normally made by either injection moulding or extrusion. When this technology was in its infancy the parison was created separately and then inflated at a later date but in a lot of cases the process can all be done in one machine. Some companies will still choose to do this as they don't have the facilities to create the own parisons.

The parison will often look something like this (insert picture) and contains the top of the bottle, often where the thread for a lid is found and the rest is a tube of plastic sealed at one end. In order to inflate the bottle, it will be secured from the thread end and pressurised air is used to inflate it. This inflation is done within a mould to control the shape of the finished bottle.

In some cases, a company will buy in their parisons from an external supplier and then inflate them on site however it is more efficient to mould them as well as inflate on site.

Products

The majority of blow moulded manufacturing is dedicated to the packaging sector, made up of bottles and containers. However, blow moulded parts can still be found in many areas such as;

- Automotive parts
- Toys
- Drums
- Fuel Tanks
- Garbage Cans
- One-piece Chairs
- Pharmaceutical Bottles
- Water Bottles

(Groover, 2010) (Valencia Plastics, 2018)

Limitations

Thermoplastics are the only materials that can be used for blow moulding, polyethylene being the most common (Groover, 2010). High density and high molecular weight being favoured, although costing more their increased strength and stiffness allows the walls of the container/bottle being made to be thinner so therefore is cheaper per bottle.

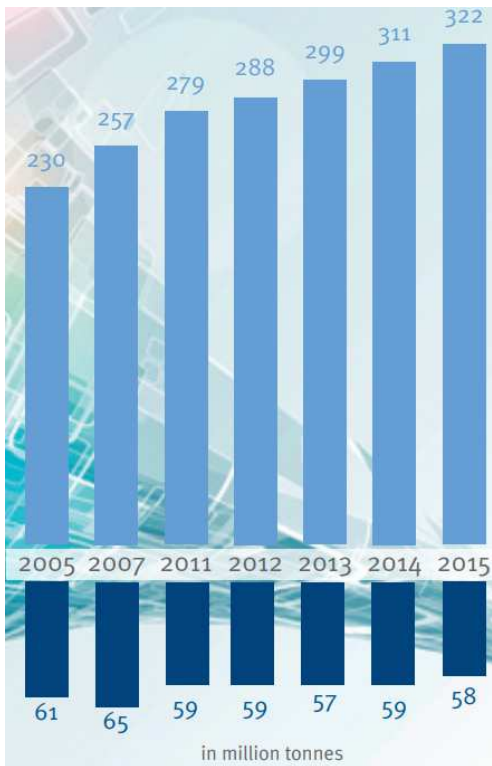
Blow moulding is limited to hollow forms, the larger the form gets the less control you have over the wall thickness. (Career Trend, 2017)

Suitable materials are;

- Low Density Polyethylene (LDPE)
- High Density Polyethylene (HDPE)
- Polyethylene Terephthalate (PET)
- Polypropylene (PP)
- Polyvinyl Chloride (PVC)

(Custompart.net, 2017)

Health & Safety



Most health and safety implications relating to plastic bottles do not come from the manufacturing of the products. It is more related to the environment and how this is affecting our food. Plastic waste is making its way into the food chain due to waste ending up in our oceans as well as on land.

“The human population is eating fish that have eaten other fish and marine organisms, which have eaten toxin-saturated plastics. In essence, we humans are eating our own plastic waste.”

Similarly, on land, plastic is eaten by a variety of animals and the same process happens again. The animals either die, thus limiting the food available for their prey. Or become contaminated and are eaten by prey or by us.

This graph from (Plastics Europe, 2016) shows the world production of plastic in millions of tonnes, with Europe’s contribution underneath. This shows a steady increase year on year of plastic use. With 39.9% of this usage being taken up by the packaging sector.

This growth is likely to carry on if we do not change our reliance on plastic and the health and safety implications will only get worse.

Around 38.5 million plastic bottles are used in the UK every day (Laville & Taylor, 2017) that equates to over 14 billion per year.

Environment

Wherever plastic is used there are major concerns for the environment. The blow moulding industry relies heavily on petroleum to produce plastic which in turn is used to make bottles and containers. The plastic produced by these methods is non-biodegradable so poses huge environmental issues. Some plastics are able to be recycled but there is not enough being done to ever stop the need for more and more production.

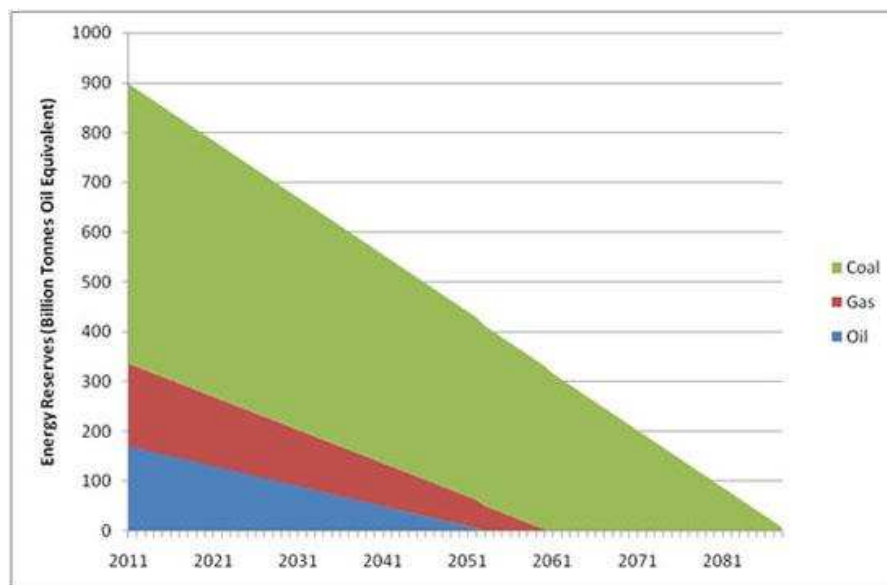
“Fewer than half of the bottles bought in 2016 were collected for recycling and just 7% of those collected were turned into new bottles. Instead most plastic bottles produced end up in landfill or in the ocean.” (Laville & Taylor, 2017)

In order to solve this problem, plastic bottles could be made from RPET, a 100% recycled polyethylene terephthalate (PET) but major drinks companies are reluctant to make this change as it is often cheaper to buy virgin material than recycled. Greenpeace carried out a survey to find out how much recycled material the biggest manufacturers used. This survey was given to six of the largest manufacturers, Coca-Cola, PepsiCo, Suntory, Danone, DrPepperSnapple and Nestle. The results found that they used a combined average of 6.6% recycled plastic in their products, despite producing bottles that are 100% recyclable.

However, PepsiCo claimed that the reason for this was that there is not enough recycled material out there for them to purchase for use in new bottles. This suggests that not enough is being done to get old bottles back into circulation as new material. In theory PET can be used again and again but unfortunately in reality it currently is not. (Johnson, 2017)

Coca-Cola claim to be slightly better in this, saying that they use 25% recycled plastic in their bottles (in the UK) and this is due to having a partnership with Clean Tech, the UK's largest recycler of PET plastic. They say they are committed to doubling the amount they recycle by 2020. (Coca-Cola, 2017)

These problems are something that will have to be dealt with soon as oil from which plastic is made is a limited quantity. According to (Ecotricity) we are currently on track to run out of oil in 2052. However, the rate at which we are using fossil fuels is actually increasing as more of the world becomes developed and starts using them. Therefore, it will actually be sooner than 2052. (Ecotricity, n.d.)



Conclusion

This report has found that blow moulded bottles are an essential part of modern life. It is likely that most people come into contact with at least one blow moulded product each day. While this has made it easy to transport liquids and convenient for customers buying these products it is important that we do not allow production to keep increasing as it is without paying more attention to recycling in order to slow the rate at which plastic is being produced. It is unlikely that we will ever get rid of plastic use completely but it is possible to recycle a far higher amount than we currently do. It will take a lot of work from all major manufacturers to get to that point but it is certainly possible.

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